EXACT

INSTRUCTION MANUAL

TYPE 100

AND

TYPE 105

VOLTAGE CALIBRATORS

C O N T E N T S

SECTION I — GENERAL DESCRIPTION

	Page
Electrical and physical Specifications	1
Basic Principles and Applications	2
Panel Finish	2

SECTION II — OPERATION

Front Panel Familiarity	4
Typical Use	5
General Considerations	8

SECTION III — CIRCUIT DESCRIPTION

SECTION IV — CALIBRATION and MAINTENANCE

Calibration Procedure	13
Trouble Shooting Guide	15
Voltage Chart	16
Replacement Parts List	18
Schematics	Back

SECTION I

GENERAL DESCRIPTION

1. ELECTRICAL SPECIFICATIONS

OUTPUT ACCURACY

Meter reads true output voltage within 3/4% of full scale

OUTPUT FREQUENCY

Selection of either DC level or 1 KC square wave (positive going from ground).

OUTPUT VOLTAGE

In 9 fixed steps from 0.01 volts to 100 volts full scale. VARIABLE control permits continuous selection of any voltage between 0.002 volts and 100 volts.

OUTPUT IMPEDANCE

1.06 ohms to approximately 2200 ohm OUTPUT IS DIRECTLY METERED SO EXTERNAL LOADING WILL NOT CAUSE ERRONEOUS INDICATION.

UNKNOWN INPUT

2mv to 100 volts may be applied for comparison with internal calibrator signal. The input impedance would be equal to the input. Impedance of the monitoring device connected to the OUTPUT.

COMPARATOR

60 cycle mechanical chopper.

105 ONLY

SQUARE WAVE SYMMETRY
Better than 0.05%

SQUARE WAVE RISETIME
1 usec.

AC POWER REQUIREMENTS
105 to 125 volts
50 - 60 cps
50 watts

2. BASIC PRINCIPLES AND APPLICATION

The Type 100 VOLTAGE CALIBRATOR is an extremely accurate variable AC or DC voltage source, designed for use with any type of measuring device, amplifier, or test equipment where a wide range of calibrating voltages is necessary to maintain dependable results.

The ability to select either a DC or 1 KC square wave output which is directly metered to nullify the effects of loading makes the Type 100 an ideal instrument for oscilloscope calibration, meter measurements, frequency compensation, etc.

105 ONLY

The 60 cycle chopper comparator in the Type 105 permits the accurate measurement of any unknown voltage from 2mv to 100V by comparing it internally at a 60 cycle rate with the calibrator voltage. This compared output can then be displayed on an oscilloscope.

3. CERAMICIZED FRONT PANEL

The panel of the Type 100 Calibrator has a specially bonded ceramic coating. This finish is extremely durable and scratch resistant. It is also impervious to normal aging and stains. The surface may be cleaned by simply wiping with a damp cloth.

SECTION II

OPERATION

1. CONTROLS AND OUTPUTS

POWER SWITCH

ON/OFF switch located in primary of transformer.

OUTPUT SWITCH

Permits selection of either steady DC voltage level or symmetrical 1 KC square wave.

OUTPUT/METER VOLTS

(1) Special VARIABLE control which combines coarse-fine operation permits selection of any voltage between full scale range settings of attenuator switch.

(2) Nine-position rotary switch selects the proper 0.05% precision output resistors to give the indicated full scale output voltage.

METER

Plus or minus 1/2% indicating meter. Full scale reading is determined by setting of OUTPUT/METER VOLTS switch.

OUTPUT

BNC output jack. 1.06 to 2200 ohm impedance.

UNKNOWN INPUT

BNC INPUT jack to one contact of chopper. Since arm of chopper goes to output, the input impedance is equal to the input impedance of the monitor scope.

MIXED- NORMAL SWITCH

Determines whether the OUTPUT is the CALIBRATOR signal only or the CALIBRATOR and UNKNOWN signal mixed. Also turns the chopper off in the NORMAL position.

2. IN TYPICAL USE

OSCILLOSCOPE CALIBRATION

Connect the putput cable from the Type 100 to the oscilloscope input.

Set OUTPUT/METER VOLTS to correct full scale range depending on desired output.

Turn Type 100 on and allow normal tube warm-up time.

Select output waveform desired - 1KC or DC.

Adjust dual-section VARIABLE control from exact voltage required.

(1) Turn VARIABLE clockwise, slightly past the desired output reading -- the coarse action is now being used.

(2) Turn VARIABLE counterclockwise to precise meter reading indicating required output -- the fine portion of the control is now in operation. A slight feeling of lost motion may be experienced when first using the FINE portion of this control; a little practice will enable the operator to make extremely accurate adjustments.

NOTE: OUTPUT ON ANY ONE RANGE MAY NOT BE TURNED TO ZERO. DO NOT USE FIRST 20% of METER SCALE.

FOR EXAMPLE:

If you wish to calibrate your scope for 11 volts/cm, adjust the Type 100 for 44 volts output in the manner outlined. Feed the output of the Type 100 to the input of the scope and adjust the oscilloscope gain controls for exactly 4 cm of deflection.

TO COMPARE AN UNKNOWN SIGNAL:

With the Type 105 METER/VOLTS switch set to 100 volts, apply the signal to the UNKNOWN INPUT jack.

Connect the OUTPUT of the 105 to an oscilloscope whose gain has been set somewhere around 20 volts/cm.

Switch the output selector to MIXED and the FREQUENCY to the opposite of the unknown. (If you have a DC unknown, use 1 KC. If your unknown is AC, use the DC position.)

Reduce the METER/VOLTS setting of the Type 105 and increase the gain of the scope until two different traces are observed, then adjust the METER/VOLTS VARIABLE control until the tops of the traces are superimposed. The meter will now read the exact voltage of the UNKNOWN INPUT.

NOTE: IT IS EASIER TO MAKE COMPARISONS IF THE OSCILLOSCOPE SWEEP IS FREE-RUNNING AT A FAIRLY FAST SPEED.

3. GENERAL CONSIDERATIONS

This unit is furnished with a 3-wire powercord to permit safer operation and meet the several State codes.

The electronically regulated power supplies will furnish the required internal voltage from an input of 105 to 125 volts. Since regulation is based on peak to peak voltage, any severe distortion to the input sine wave will cause improper regulation.

The cabinet and front panel will be warm to the touch after several hours of operation. This will have no effect on accuracy because of the thermal compensation of meter/output circuits. DO NOT BLOCK VENT HOLES.

A 3/4 amp protective fuse is located inside the cabinet and normal precautions should be taken before replacing.

Although the 1/2% meter is designed to withstand normal handling, severe shocks or exposure to heavy magnetic fields could destroy calibration.

105 ONLY

The mechanical chopper has a definite useable life and should be turned off when you are not comparing an unknown signal.

SECTION III

1. CIRCUIT DESCRIPTION

TRANSFORMER

Filament and all DC voltages are supplied by a single transformer T100 which operates satisfactorily between 105 -- 125 volts. This transformer has a single 117 volt primary; two hi-voltage secondaries and one 6.5 volt filament winding.

RECTIFIERS

The hi-voltage AC is rectified by silicon rectifiers connected in a full wave bridge.

-150 VOLT REGULATED SUPPLY

All DC voltages in the Type 100 must have a stable reference voltage in order to properly regulate against load and input variations. V2, a gas diode, is this stabilized reference and sets the cathode voltage of VI. Any variation across the bias divider resistors R16 and R18 will be greatly amplified and inverted through VI causing a correcting change in current flow through V4B. R10 by-passes V4B and reduces the load current through it.

+175 VOLT SUPPLY

This supply operates in essentially the same way as the -150 volt supply except that the -150 volt supply becomes the reference for divider resistors R7 and R8. Any variation is amplified by V3, thereby changing the current in V4A.

2. WAVEFORM GENERATOR

TRIGGER GENERATOR

V51 is connected as a free-running cathode-coupled multivibrator whose frequency is normally adjusted to 2KC by R51. An unsymmetrical square wave is produced at the common cathode.

The arm of R51 is connected to the OUTPUT switch. When this switch is in the DC position, a negative bias sufficient to cut off V51 is furnished from the -150 volt supply through divider resistors R66 and R50.

TRIGGER SHAPER/AMPLIFIER

The unsymmetrical square wave from V51 is differentiated by C52 and R56. This waveform is applied to the grids of V52 and limited so that only the positive excursion is amplified. The negative going spike at the plates of V52 is simultaneously applied to the grids of V53 and V54.

BI-STABLE MULTIVIBRATOR

The screen coupled bi-stable multivibrator composed of V53 and V54 controls the grid voltage of V55 when the OUTPUT switch is in the 1KC position. A negative trigger from V52 starts the action by driving the grid of the conducting side of the multi (V54) more negative. As conduction in V54

decreases the resultant rise in screen voltage is coupled to the grid of V53 causing it to go into conduction. The corresponding drop in plate voltage is coupled back to the grid of V54. The biases are adjusted such that when V53 is conducting full, V54 is cut-off. This stable state is maintained until the next negative trigger arrives from V52 causing the action to reverse and the multi to return to its original quiescent state. SINCE ONLY THE NEGATIVE SPIKES FROM THE TRIGGER GENERATOR V51 SWITCH THE MULTIVIBRATOR, A 1KC SQUARE WAVE IS GENERATED WHOSE SYMMETRY IS LIMITED ONLY BY THE FREQUENCY STABILITY OF V51 (about one part in ten thousand).

MAX. OUTPUT ADJ.

R67 sets the maximum voltage to which the plate of V54 can rise.

The VARIABLE control R68 is a mechanically linked dual COARSE-FINE potentiometer which sets the positive voltage level at the plate of V54.

In the DC position of the OUTPUT switch, the multivibrator is rendered inoperative by disconnecting the cathode of V54. Plate voltage of V54 rises to whatever level is selected by the VARIABLE control.

METER/OUTPUT CIRCUIT

The symmetrical 1KC square wave or DC level is fed to the grid of output cathode follower V55 from the plate of V54. Cathode resistance of this stage is composed of .05% resistors which proportionately divide the output voltage.

A 0-200 ua meter is connected across the 0.5 VOLT output tap and monitors the proportional voltage drop at this point. This direct metering permits accurate results even under conditions of extreme loading. Meter rectification is not needed in the 1KC position due to the exceptional symmetry of the waveform.

Since only half as much average current flows through the meter in the 1KC position as in the DC position, meter shunts R70 and R71 must be switched in when in the DC position. METER BALANCE ADJ. R72 compensates for slight differences in total meter resistance and standardizes the output accuracy.

CHOPPER COMPARATOR CIRCUIT

The 60 cycle chopper comparator is connected in such a way that the OUTPUT alternately sees the UNKNOWN INPUT jack and then the internal calibrator signal. Power to run the chopper is furnished by 6.3V taken from the pilot light/filament line. In the NORMAL position, power is removed from the chopper and the OUTPUT jack is connected directly to the internal calibrator signal.

SECTION IV

MAINTENANCE

1. CALIBRATION PROCEDURE

COOLING AND CLEANING

The TYPE 100 CALIBRATOR is cooled by convection and it is quite important to keep the inside clean as well as the ventilation holes unobstructed.

REMOVAL OF CASE

To remove instrument from cabinet, loosen two screws at each end and lift case off.

TUBE REPLACEMENT

Any tube may be replaced without affecting calibration accuracy. FREQ. ADJ. pot R51 will usually need readjustment when V51 is changed.

POWER SUPPLY

Check -150 volt and +175 volt supplies for accuracy (plus or minus 5%) and regulation (105V to 125V).

TRIGGER GENERATOR

Frequency may be adjusted over a limited range by FREQ. ADJ. R51. This adj. is made at the factory for a 1KC output.

BI-STABLE MULTIVIBRATOR

Maximum range of the front panel VARIABLE control can be set by MAX. OUTPUT R67. For best results, turn VARIABLE control fully clockwise and adjust R67 several degrees past full scale meter reading.

METER/OUTPUT STAGE

The purpose of METER BALANCE R72 is to adjust total meter resistance for 1250 ohms, thus standardizing the output accuracy. This adjustment is made at the factory and the pot sealed with a drop of red paint. READJUSTMENT OF THIS POT SHOULD NOT BE NECESSARY IN THE FIELD. If it does become necessary to recompensate the meter (indicated by a significant change in meter reading when switching between 1KC and DC OUTPUT positions), the following procedure should be used:

1. Set OUTPUT to DC position.
2. Set OUTPUT/METER VOLTS switch to 100 volts.
3. Using a standard such as a FLUKE 0.05% Differential Voltmeter, adjust VARIABLE control for 99 volts as indicated by standard.
4. Adjust METER BALANCE R72 for a meter reading of 99 volts.
5. Switch OUTPUT from DC to 1KC several times rapidly. Reading should not change more than a needle width.

2. TROUBLE SHOOTING GUIDE

TUBES FAIL MUCH MORE OFTEN THAN COMPONENTS. CHECK THEM BY REPLACEMENT FIRST.

Check power supplies for proper voltage and regulation.

No output in the 1KC position indicates trouble in the waveform generator section. Check for trigger from V51 and replace tubes in following order: V51 - V52 - V53 - V54.

Distortion of square wave indicates trouble in V53, V54 or output stage, V55.

No output in either DC or 1KC position indicates trouble in V55.

Meter not making full scale indicates improper setting of R67 MAX. ADJ. pot or defective resistors in the plate circuit of V54.

[105 ONLY]

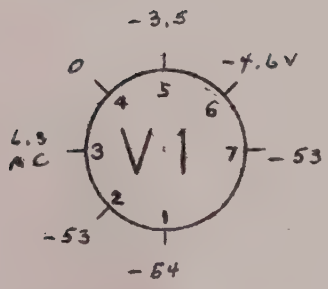
No mixing action suggests faulty chopper. Check 6.3 volts and replace chopper.

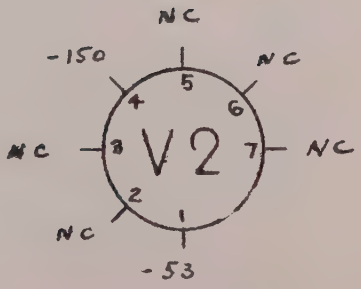
3. VOLTAGE CHART

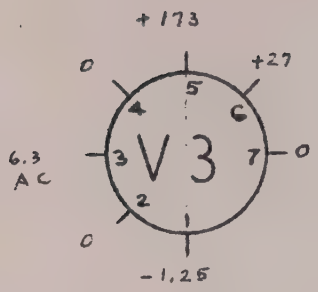
The listed tube socket voltages were measured with a 20,000 ohm/volt voltmeter. Front panel controls were set in the following positions:

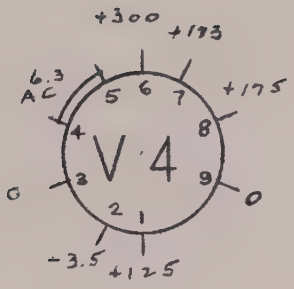
OUTPUT 1KC

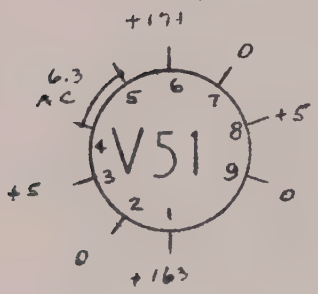
Output/Meter ..... Switch 100
volts ..... Variable ..... CW

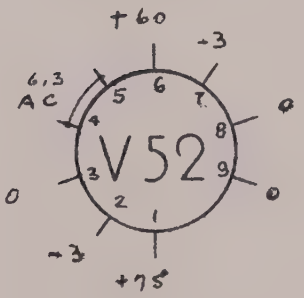


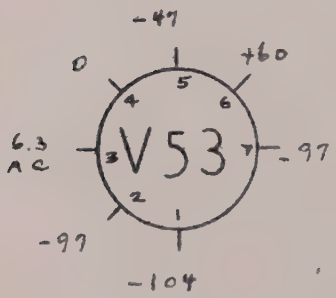


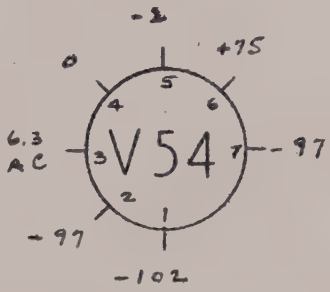

+173
0
+27
6.3
AC
V3
0
-1.25

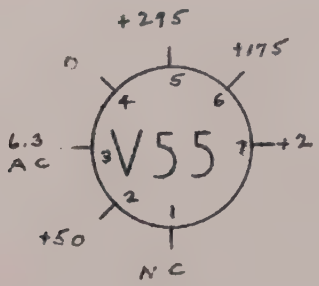

+300
+173
6.3
AC
+175
V4
0
-3.5
+125


+171
6.3
AC
0
+5
V51
+5
0
+163


+60
-3
6.3
AC
V52
0
-3
+75


-47
0
+60
6.3
AC
V53
-97
-97
-104


-2
0
+75
6.3
AC
V54
-97
-97
-102


+295
0
+175
6.3
AC
V55
+2
+50
NC

4. REPLACEMENT PARTS LIST

EXACT will supply replacement parts at current net prices. Since most components are standard electronic parts, we suggest you purchase them through your local distributor if possible after checking the instruction manual for tolerances.

ABBREVIATIONS

Cer. ceramic

DPDT	double pole double throw	m	milli
		ohm	ohm
Elect	electrolytic	prec	precision
f	farad	PT	paper tubular
K	X1000ohm	V	working volts DC
M	X1,000,000ohm	Var	variable
u	micro	W	watt
uu	micro micro	WW	wirewound

POWER SUPPLY

BULBS

B1

CAPACITORS

C1A,B,C	10-15-20uf	Elect.	450V
C2	.01uf	PT	400V
C3	2x20uf	Elect.	450V
C4	.01uf	PT	400V
C6	2x20uf	Elect.	450V

FUSE

Fuse	3/4 amp	3AG	SLO-BLO

RECTIFIERS

SL100	silicon	150 ma per leg
SL101	silicon	150 ma per leg

RESISTORS

R1	10ohm	1W	10%	
R3	1.5M	1/2W	10%	
R4	680K	1/2W	10%	
R5	47K	1/2W	10%	
R6	100K	1/2W	10%	
R7	100K	1/2W	1%	Prec.
R8	120K	1/2W	1%	Prec.
R9	10ohm	1W	10%	
R10	6K	5W	5%	WW
R11	470K	1/2W	10%	
R12	1.5M	1/2W	10%	
R13	5.6	1/2W	10%	
R14	120K	1/2W	10%	
R15	10K	1/2W	10%	
R16	100K	1/2W	1%	Prec.
R18	150K	1/2W	1%	Prec.
R19	2.7K	1W	10%	
R20	180K	1/2W	10%	

* Type 105 Only *

RELAYS

K100	60 cycle	chopper

SWITCHES

SW1	DPDT	Power
SW100	DPDT	Mixed-Normal

TRANSFORMERS

T100 PLATE AND HEATER SUPPLY

VACUUM TUBES

V1	6AU6	-150V DC AMP
V2	5651	VOLTAGE REFERENCE
V3	6AU6	+175 DC AMP
V4A	1/2 12BH7	-150 SERIES REG.
V4B	1/2 12BH7	+175 SERIES REG.

VOLTAGE GENERATOR

CAPACITORS

C51	82uuf	cer.	500V
C52	82uuf	cer.	500V
C53	12uuf	cer.	500V
C54	12uuf	cer.	500V
C55	.01uf	cer.	250V

RESISTORS

R51	1.5M	2W	20%	Var.
R52	1.8M	1/2W	10%	
R53	10K	1/2W	10%	
R54	10K	1/2W	10%	
R55	2.2K	1/2W	10%	
R56	2.7K	1/2W	10%	
R57	120K	1/2W	10%	
R58	18K	1W	10%	
R59	22K	2W	10%	
R60	18K	2W	10%	
R61	22K	2W	10%	
R62	270K	1/2W	10%	
R63	270K	1/2W	10%	
R64	100K	1/2W	10%	
R65	100K	1/2W	10%	
R66	3.9K	2W	10%	
R67	10K	2W	20%	Var.
R68	10K/5K	2W	20%	Dual Var.
R69	15K	5W	5%	WW
R70	1250ohm	1/2W	.05%	Prec.
R71	625ohm	1/2W	.05%	Prec.
R72	200ohm	2W	20%	Var.
R73	5K	2W	.05%	Prec.

R74	4K	1W	.05%	Prec.
R75	500ohm	1/2W	.05%	Prec.
R76	400ohm	1/2W	.05%	Prec.
R77	50ohm	1/2W	.05%	Prec.
R78	41.68ohm	1/2W	.05%	Prec.
R79	5.21ohm	1/2W	.05%	Prec.
R80	4.168ohm	1/2W	.05%	Prec.
R81	1.042ohm	1/2W	.05%	Prec.
R83	100K	1/2W	10%	

SWITCHES

SW51	DPDT	Output

VACUUM TUBES

V51	12AT7	TRIGGER GENERATOR
V52	12AT7	TRIGGER SHAPER/AMP
V53	6AU6	BI-STABLE MULTI
V54	6AU6	
V55	6aQ5	OUTPUT CF